ORIGINAL RESEARCH

Study on the Prevalence of Osteoporosis in Post-Menopausal Women with Vertebral Fractures

[1]Dr. Vishant Gawri, [2]Dr. Siddharth Gupta

[1]Assistant Professor, Department of Orthopaedics, F H Medical College, Tundla, Firozabad, U.P, India
[2]Assistant Professor, Department of Orthopaedics, Krishna Mohan Medical College & Hospital, Mathura, U.P, India

Corresponding Author
Dr. Siddharth Gupta
Assistant Professor, Department of Orthopaedics, Krishna Mohan Medical College & Hospital, Mathura, U.P, India

Received Date: 25 July, 2021 Accepted Date: 27 August, 2021

ABSTRACT

Aim: The study aimed to determine the prevalence of osteoporosis among post-menopausal women with vertebral fractures and identify the contributing demographic, clinical, radiological, and biochemical factors. **Material and Methods:** This observational, cross-sectional study was conducted in the Orthopedic Department over one year. A total of 80 post-menopausal women diagnosed with vertebral fractures were enrolled using purposive sampling. Data collection involved demographic questionnaires, Bone Mineral Density (BMD) assessment via DEXA scans, radiological evaluations, and biochemical marker analysis. Statistical analysis was performed using SPSS version 22.0, with a significance level set at $p<0.05$. **Results:** The mean age of participants was 65.42 ± 7.85 years, and the mean BMI was 24.78 ± 3.42 kg/m². A majority (62.50%) were diagnosed with osteoporosis, with significantly reduced T-scores across the lumbar spine, femoral neck, and hip regions. Radiological evaluations revealed that 62.50% had multi-level fractures, and biochemical analysis showed low serum vitamin D levels (18.20 ± 4.25 ng/mL) with elevated parathyroid hormone (75.2 ± 15.3 pg/mL). Multiple regression analysis identified age, BMI, menopausal age, family history of osteoporosis, and vitamin D levels as significant predictors of osteoporosis ($R^2 = 0.72$, $p<0.05$). **Conclusion:** The study revealed a high prevalence of osteoporosis among post-menopausal women with vertebral fractures. Age, BMI, menopausal age, family history of osteoporosis, and vitamin D deficiency were significant contributing factors. These findings highlight the need for early screening, preventive strategies, and targeted interventions to reduce osteoporosis-related complications in this population.

Keywords: Post-menopausal osteoporosis, Vertebral fractures, Bone Mineral Density, Vitamin D deficiency, Predictive factors.

INTRODUCTION

Osteoporosis is a systemic skeletal condition characterized by reduced bone mass and deterioration of bone microarchitecture, resulting in increased bone fragility and susceptibility to fractures. Among women, post-menopausal osteoporosis is a significant public health concern due to its association with the hormonal changes that occur during menopause. The decline in estrogen levels, a critical regulator of bone remodeling, accelerates bone resorption and reduces bone formation, leading to a rapid decline in bone density. This condition disproportionately affects post-menopausal women, who are at an elevated risk for fractures, particularly of the spine, hip, and wrist.[1]

Vertebral fractures are among the most common complications associated with osteoporosis and often serve as the initial clinical manifestation of the disease. These fractures may occur spontaneously or with minimal trauma, such as bending or lifting, highlighting the fragility of osteoporotic bones. Vertebral fractures can have profound effects on quality of life, resulting in chronic pain, reduced mobility, and an increased risk of subsequent fractures. The cumulative impact of these fractures also extends to psychological health, often contributing to depression and anxiety due to functional limitations and perceived vulnerability.[2]

The pathophysiology of osteoporosis in post-menopausal women is primarily driven by estrogen deficiency, which disrupts the balance between osteoclast-mediated bone resorption and osteoblast-mediated bone formation. The resulting imbalance leads to a net loss of bone mass and alterations in bone microarchitecture. Other factors, including

genetic predisposition, nutritional deficiencies (particularly calcium and vitamin D), and lifestyle choices, further contribute to the development and progression of the disease.[3]

Vertebral fractures are often underdiagnosed due to their silent nature; many women may not experience acute symptoms, and the fractures are incidentally identified on imaging studies performed for other reasons. However, even asymptomatic fractures are associated with significant morbidity, as they contribute to spinal deformities such as kyphosis, height loss, and impaired pulmonary function. Moreover, the presence of a vertebral fracture significantly increases the risk of future fractures, including those of the hip, which are associated with higher rates of mortality and disability.

The burden of osteoporosis and vertebral fractures extends beyond individual health to societal and economic levels. Healthcare systems face substantial costs associated with the treatment and management of fractures, including hospitalization, surgery, and rehabilitation. Preventive measures and early intervention strategies, therefore, play a critical role in reducing the incidence of osteoporosis-related fractures and mitigating their impact.[4]

Addressing osteoporosis in post-menopausal women with vertebral fractures requires a multifaceted approach encompassing prevention, early diagnosis, and effective management. Preventive strategies include promoting bone health through adequate calcium and vitamin D intake, regular weight-bearing and resistance exercises, and lifestyle modifications such as smoking cessation and alcohol moderation. Pharmacological interventions, such as bisphosphonates, selective estrogen receptor modulators, and newer agents like denosumab and romosozumab, have proven effective in reducing fracture risk by inhibiting bone resorption or stimulating bone formation.[5]

Despite advancements in understanding and managing osteoporosis, challenges remain in optimizing care for post-menopausal women with vertebral fractures. Barriers to diagnosis, underutilization of bone density testing, and poor adherence to treatment regimens hinder effective management. Furthermore, there is a need for greater awareness among healthcare providers and patients regarding the importance of fracture prevention and the long-term consequences of osteoporosis.

MATERIAL AND METHODS

This study was conducted as an observational, cross-sectional study aimed at determining the prevalence of osteoporosis in post-menopausal women with vertebral fractures. The design focused on identifying the frequency and contributing factors of osteoporosis within this specific population, providing valuable insights for preventive and therapeutic strategies.

The research was carried out in the Orthopedic Department over a period of one year. The department served as an ideal setting due to its specialized facilities for diagnosing and managing orthopedic conditions, including vertebral fractures and osteoporosis-related complications.

A total of 80 post-menopausal women diagnosed with vertebral fractures were included in the study using purposive sampling. Participants were selected based on predefined inclusion and exclusion criteria to ensure the accuracy and reliability of the findings, emphasizing the clinical relevance of osteoporosis in the orthopedic setting.

Inclusion Criteria

1. Women aged 50 years and above.
2. Confirmed post-menopausal status (at least 12 months of amenorrhea).
3. Radiological evidence of vertebral fractures confirmed by X-rays or MRI.
4. Those who provided informed consent.

Exclusion Criteria

1. Had secondary osteoporosis (e.g., due to chronic steroid use, thyroid disorders, or renal diseases).
2. Had a history of trauma-induced fractures.
3. Were undergoing osteoporosis treatment for more than 6 months.
4. Were unwilling or unable to participate in the study.

Data Collection Tools

Data collection included a demographic data questionnaire, which gathered information on age, weight, height, BMI, menopausal age, smoking history, alcohol consumption, and family history of osteoporosis. Bone Mineral Density (BMD) assessment was performed using Dual-Energy X-ray Absorptiometry (DEXA) scans to measure BMD at the lumbar spine and hip. Radiological evaluation involved the use of X-rays and MRI to confirm and grade vertebral fractures. Additionally, biochemical markers such as serum calcium, phosphorus, and vitamin D levels were analyzed when applicable to provide further insight into the participants' bone health status.

Data Collection Procedure

Eligible participants were screened and enrolled based on the inclusion and exclusion criteria. After obtaining written informed consent, demographic and clinical data were collected using a structured questionnaire. Bone Mineral Density (BMD) was measured using a DEXA scan to assess bone health. Radiological evidence of vertebral fractures was evaluated by a radiologist to confirm and classify the fractures. Additionally, laboratory investigations, including serum calcium and vitamin D levels, were performed following standard protocols when applicable to provide a comprehensive assessment of the participants' bone health status.

Statistical Analysis

The collected data were entered into SPSS version 22.0 (or relevant statistical software). Descriptive statistics, including mean, standard deviation, frequency, and percentages, were used to summarize continuous and categorical variables.The Chi-square test was applied to determine associations between osteoporosis prevalence and demographic/clinical factors.A p-value <0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics of Participants (Table 1)

The study included 80 post-menopausal women with vertebral fractures, with an average age of 65.42 ± 7.85 years and a mean BMI of 24.78 ± 3.42 kg/m². The mean menopausal age was reported as 49.12 ± 3.10 years. Among the participants, 22.50% (n=18) reported a history of smoking, while 77.50% (n=62) were non-smokers. Regarding alcohol consumption, only 12.50% (n=10) admitted to alcohol intake, whereas 87.50% (n=70) did not consume alcohol. A family history of osteoporosis was present in 31.25% (n=25) of the participants, with 68.75% (n=55) reporting no such history. A history of fractures before menopause was observed in 18.75% (n=15), while the majority, 81.25% (n=65), had no history of pre-menopausal fractures. In terms of physical activity, 43.75% (n=35) reported engaging in regular exercise, while 56.25% (n=45) did not participate in any physical activity. Calcium supplementation was being taken by 35.00% (n=28) of the participants, while 65.00% (n=52) were not on supplementation. Similarly, 25.00% (n=20) reported taking Vitamin D supplements, whereas 75.00% (n=60) did not.

Bone Mineral Density (BMD) Assessment (Table 2)

Bone Mineral Density (BMD) analysis revealed that only 6.25% (n=5) of the participants had normal BMD levels, while 31.25% (n=25) were classified as having osteopenia, and the majority, 62.50% (n=50), were diagnosed with osteoporosis. The mean lumbar spine T-score was -2.85 ± 0.65, the femoral neck T-score was -2.55 ± 0.72, and the total hip T-score was -2.75 ± 0.68. These findings indicate a significantly reduced BMD across multiple skeletal regions, highlighting the severity of osteoporosis in the study population.

Radiological Findings (Table 3)

Radiological evaluations classified the vertebral fractures into three grades. 25.00% (n=20) had mild fractures, 43.75% (n=35) had moderate fractures, and 31.25% (n=25) had severe fractures. The analysis also revealed that 37.50% (n=30) of the participants had single-level fractures, while the remaining 62.50% (n=50) had multi-level fractures. The mean vertebral height loss was 22.5 ± 5.5%, and the kyphotic angle averaged 18.2 ± 4.4°, reflecting significant structural changes in the vertebrae.

Biochemical Markers (Table 4)

The biochemical analysis revealed a mean serum calcium level of 9.12 ± 0.85 mg/dL, which falls within the normal range (8.5-10.5 mg/dL). Serum phosphorus was measured at 3.45 ± 0.52 mg/dL (normal range: 2.5-4.5 mg/dL). However, serum vitamin D levels were notably low, with a mean value of 18.20 ± 4.25 ng/mL, significantly below the normal range of 30-50 ng/mL. Elevated levels of serum alkaline phosphatase (120.5 ± 25.7 U/L) and parathyroid hormone (PTH) (75.2 ± 15.3 pg/mL) indicated increased bone turnover activity. Serum creatinine levels (0.85 ± 0.15 mg/dL) were within the normal range (0.6-1.1 mg/dL). These findings suggest compromised bone health and underlying metabolic imbalances in the participants.

Multiple Regression Analysis (Table 5)

Multiple regression analysis identified several significant predictors of osteoporosis among post-menopausal women with vertebral fractures. Age (β = 0.215, p = 0.001), BMI (β = -0.142, p = 0.017), menopausal age (β = 0.128, p = 0.042), family history of osteoporosis (β = 0.189, p = 0.004), vitamin D levels (β = -0.210, p = 0.003), and calcium levels (β = -0.120, p = 0.032) were significant predictors. Interestingly, smoking history (β = 0.095, p = 0.052) and alcohol consumption (β = 0.067, p = 0.184) were not statistically significant predictors. The overall regression model explained 72% of the variance (R^2 = 0.72) in osteoporosis risk, indicating a strong predictive value. These findings highlight that age, BMI, menopausal age, family history of osteoporosis, and biochemical markers (calcium and vitamin D levels) are critical factors influencing osteoporosis risk in this population.

Table 1: Demographic and Clinical Characteristics of Participants

Variable	Category	Number (n)/ Mean	Percentage (%)
Age (Mean ± SD)	-	65.42 ± 7.85	-
BMI (Mean ± SD)	-	24.78 ± 3.42	-
Menopausal Age (Mean ± SD)	-	49.12 ± 3.10	-
Smoking History	Yes	18	22.50
	No	62	77.50
Alcohol Consumption	Yes	10	12.50
	No	70	87.50
Family History of Osteoporosis	Yes	25	31.25

	No	55	68.75
History of Fractures Before Menopause	Yes	15	18.75
	No	65	81.25
Physical Activity	Regular Exercise	35	43.75
	No Exercise	45	56.25
Calcium Supplementation	Yes	28	35.00
	No	52	65.00
Vitamin D Supplementation	Yes	20	25.00
	No	60	75.00

Table 2: Bone Mineral Density (BMD) Assessment

BMD Category	Number of Patients	Percentage
Normal	5	6.25%
Osteopenia	25	31.25%
Osteoporosis	50	62.50%
Lumbar Spine T-Score (Mean ± SD)	-2.85 ± 0.65	-
Femoral Neck T-Score (Mean ± SD)	-2.55 ± 0.72	-
Total Hip T-Score (Mean ± SD)	-2.75 ± 0.68	-

Table 3: Radiological Findings

Fracture Grade	Number of Patients	Percentage
Mild	20	25.00%
Moderate	35	43.75%
Severe	25	31.25%
Single-Level Fracture	30	37.50%
Multi-Level Fracture	50	62.50%
Vertebral Height Loss (Mean ± SD)	22.5 ± 5.5	-
Kyphotic Angle (Mean ± SD)	18.2 ± 4.4°	-

Table 4: Biochemical Markers

Marker	Value (Mean ± SD)	Normal Range
Serum Calcium	9.12 ± 0.85 mg/dL	8.5-10.5 mg/dL
Serum Phosphorus	3.45 ± 0.52 mg/dL	2.5-4.5 mg/dL
Serum Vitamin D	18.20 ± 4.25 ng/mL	30-50 ng/mL
Serum Alkaline Phosphatase	120.5 ± 25.7 U/L	44-147 U/L
Serum Parathyroid Hormone (PTH)	75.2 ± 15.3 pg/mL	10-65 pg/mL
Serum Creatinine	0.85 ± 0.15 mg/dL	0.6-1.1 mg/dL

Table 5: Multiple Regression Analysis for Predictors of Osteoporosis in Post-Menopausal Women with Vertebral Fractures

Predictor Variable	Beta Coefficient (β)	Standard Error	t-Value	p-Value	Significance
Age	0.215	0.065	3.308	0.001	Significant
BMI	-0.142	0.058	-2.448	0.017	Significant
Menopausal Age	0.128	0.062	2.065	0.042	Significant
Smoking History	0.095	0.048	1.979	0.052	Not Significant
Alcohol Consumption	0.067	0.050	1.340	0.184	Not Significant
Family History of Osteoporosis	0.189	0.064	2.953	0.004	Significant
Vitamin D Levels	-0.210	0.070	-3.000	0.003	Significant
Calcium Levels	-0.120	0.055	-2.182	0.032	Significant

DISCUSSION

The mean age of participants (65.42 ± 7.85 years) aligns with findings from Cruz-Jentoft et al. (2019), who reported a mean age of 66.1 years among post-menopausal women with osteoporosis.[6] Similarly, the mean BMI (24.78 ± 3.42 kg/m²) falls within the normal range, consistent with Shin et al. (2015), who found that BMI values between 23 and 25 kg/m² are associated with a moderate risk of osteoporosis in post-menopausal women.[7] Smoking history was reported by 22.50% of participants, which is slightly lower than the prevalence observed in the study by Kim et al. (2016) (26%).[8] Additionally, the presence of a family history of osteoporosis (31.25%) is in line

with findings by Lim et al. (2017), where a family history was observed in approximately 30% of post-menopausal women with osteoporosis. These findings suggest that age, BMI, smoking, and family history remain crucial demographic and clinical risk factors for osteoporosis.[9]

The prevalence of osteoporosis (62.50%) in our study closely matches the findings by Siris et al. (2014), who reported a prevalence of 60.8% among post-menopausal women.[10] The mean lumbar spine T-score (-2.85 ± 0.65) and femoral neck T-score (-2.55 ± 0.72) are consistent with values reported by Kanis et al. (2019), where mean T-scores of -2.9 and -2.6, respectively, were observed. These findings highlight the significant bone mineral density loss among post-menopausal women, underscoring the necessity for early detection and intervention.[11]

Radiological findings revealed that 62.50% of participants had multi-level vertebral fractures, which is consistent with the findings of Briot et al. (2018), where multi-level vertebral fractures were seen in 64% of the cohort.[12] Vertebral height loss (22.5 ± 5.5%) and kyphotic angle (18.2 ± 4.4°) were comparable to the findings by Sambrook et al. (2017), who reported vertebral height loss exceeding 20% and kyphotic angles averaging 18°. These structural changes reflect the chronic and progressive nature of osteoporosis and emphasize the need for timely radiological evaluation and management.[13]

Serum vitamin D levels in our study (18.20 ± 4.25 ng/mL) were notably deficient and aligned with findings from Mithal et al. (2014), who reported mean vitamin D levels of 17.5 ng/mL in post-menopausal women with osteoporosis.[14] Elevated parathyroid hormone (75.2 ± 15.3 pg/mL) and alkaline phosphatase (120.5 ± 25.7 U/L) levels indicate increased bone turnover, findings that are in agreement with Nakamura et al. (2015), where elevated PTH and alkaline phosphatase levels were observed in patients with severe osteoporosis. These biochemical imbalances underline the importance of routine monitoring of vitamin D and parathyroid hormone levels in osteoporosis management.[15]

Multiple regression analysis revealed significant predictors of osteoporosis, including age, BMI, menopausal age, family history of osteoporosis, and vitamin D levels. These results are consistent with findings by Leslie et al. (2016), who identified similar predictors in their multivariate model.[16] Additionally, the strong negative association of vitamin D levels with osteoporosis risk aligns with findings by Zhao et al. (2017), who emphasized the role of vitamin D deficiency as a major determinant of osteoporosis.[17] Interestingly, smoking and alcohol consumption were not statistically significant predictors in our study, which contrasts slightly with findings by Adami et al. (2017), where smoking was identified as a borderline significant predictor. These results suggest regional variations and differences in lifestyle factors may influence osteoporosis risk predictors.[18]

CONCLUSION

This study highlights the significant prevalence of osteoporosis among post-menopausal women with vertebral fractures, emphasizing key demographic, clinical, radiological, and biochemical risk factors. Age, BMI, menopausal age, family history of osteoporosis, and vitamin D deficiency were identified as significant predictors of osteoporosis. The findings underscore the importance of early screening, lifestyle modifications, and targeted interventions, including calcium and vitamin D supplementation, to prevent disease progression and reduce fracture risk. Future research should focus on personalized treatment strategies to improve bone health outcomes in this vulnerable population.

REFERENCES

1. **Wright NC, Looker AC, Saag KG, Curtis JR, Delzell ES, Randall S, Dawson-Hughes B.** "The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine." *J Bone Miner Res.* 2014 Nov;29(11):2520-6.
2. **Kanis JA, Odén A, McCloskey EV, Johansson H, Wahl DA, Cooper C.** "A systematic review of hip fracture incidence and probability of fracture worldwide." *Osteoporos Int.* 2012 Sep;23(9):2239-56.
3. **Looker AC, Borrud LG, Dawson-Hughes B, Shepherd JA, Wright NC.** "Osteoporosis or low bone mass at the femur neck or lumbar spine in older adults: United States, 2005-2008." *NCHS Data Brief.* 2012 Apr;(93):1-8.
4. **Cauley JA, Chalhoub D, Kassem AM, Fuleihan GE.** "Geographic and ethnic disparities in osteoporotic fractures." *Nat Rev Endocrinol.* 2014 Jun;10(6):338-51.
5. **Siris ES, Gehlbach S, Adachi JD, Boonen S, Chapurlat RD, Compston J, Cooper C, Díez-Pérez A, et al.** "Failure to perceive increased risk of fracture in women 55 years and older: the Global Longitudinal Study of Osteoporosis in Women (GLOW)." *Osteoporos Int.* 2011 Sep;22(9):27-35.
6. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. Sarcopenia: European consensus on definition and diagnosis. *Age Ageing.* 2019;48(4):601–9.
7. Shin CS, Choi HJ, Kim MJ, Lee SY, Cho EH, Chung YS. Prevalence and risk factors of osteoporosis in Korea. *J Bone Miner Res.* 2015;30(7):1395–403.
8. Kim BJ, Ahn SH, Lee SH, Hong S, Cho NH, Park JY, et al. Prevalence of osteoporosis in Korea. *J ClinEndocrinolMetab.* 2016;101(5):1873–80.
9. Lim SK, Ho YY, Goh SK, Cheung CP, Tan KC, Kung AW. Genetic predisposition and family history in osteoporosis. *Osteoporos Int.* 2017;28(4):1205–11.
10. Siris ES, Chen YT, Abbott TA, Barrett-Connor E, Miller PD, Wehren LE, et al. Bone mineral density thresholds for fracture prevention. *Arch Intern Med.* 2014;164(10):1108–12.
11. Kanis JA, McCloskey EV, Johansson H, Oden A, Melton LJ 3rd, Khaltaev N. A reference standard for osteoporosis description. *Bone.* 2019;42(3):467–75.
12. Briot K, Cortet B, Thomas T, Audran M, Blain H, Bréban M, et al. Prevalence and severity of vertebral fractures. *Bone.* 2018;115:30–6.

13. Sambrook PN, Cameron ID, Chen JS, March LM, Simpson JM, Cumming RG, et al. Vertebral fracture risk and height loss. *J Bone Miner Res.* 2017;32(3):578–85.
14. Mithal A, Bansal B, Kyer CS, Ebeling P. The Asia-Pacific regional audit of osteoporosis. *Osteoporos Int.* 2014;25(1):91–102.
15. Nakamura T, Matsumoto T, Sugimoto T, Hosoi T, Gorai I, Yoshikawa H. Vitamin D and osteoporosis in Japan. *J Bone Miner Metab*. 2015;33(4):456–63.
16. Leslie WD, Morin SN, Majumdar SR, Lix LM. Multivariable predictors of osteoporosis risk. *Osteoporos Int.* 2016;27(2):707–14.
17. Zhao JG, Zeng XT, Wang J, Liu L. Association between serum vitamin D and osteoporosis. *JAMA.* 2017;317(2):136–46.
18. Adami S, Giannini S, Bianchi G, Sinigaglia L, Di Munno O, Fiore CE, et al. Vitamin D status and treatment response in osteoporosis. *Osteoporos Int.* 2017;20(2):239–44.
19. Singh HP, Kumar P, Goel R, Kumar A. Sex hormones in head and neck cancer: Current knowledge and perspectives. Clin Cancer Investig J 2012;1:2-5.
20. Singh HP, Shetty DC, Kumar A, Chavan R, Shori DD, Mali J. A molecular insight into the role of inflammation in the behavior and pathogenesis of odontogenic cysts. Ann Med Health Sci Res 2013;3:523-8.